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James Valdez

From apples to atoms; merging worlds to build a brighter future

By Diana Del Mauro
ADEPS Communications

When you live in God's country, as James Valdez says he does, you want to help make sure the beautiful spots of America stay beautiful. And for Valdez, that means finding solutions for nuclear waste.

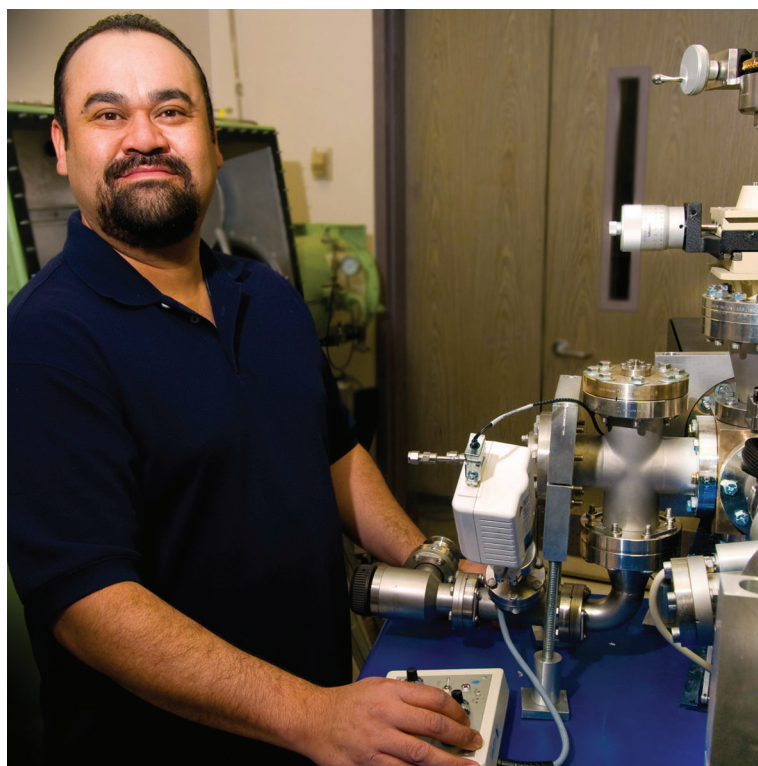
"I enjoy the out-of-doors, so keeping the environment in good shape is important to me," said Valdez, a senior materials science technologist who lives in Dixon, a village 44 miles northeast of Los Alamos where his relatives have grown apples for hundreds of years.

As Valdez sees it, the future of nuclear energy could mean "tons of energy and a ton of waste." So if he could synthesize ceramic materials that would either increase nuclear fuel burnup (a measure of nuclear-reactor fuel consumption) or securely contain nuclear waste, Valdez would consider it the pinnacle of his career as well as a gift for the next generation.

Always a fervent steward of the earth, Valdez was studying environmental science at the University of New Mexico-Los Alamos when he said he "fell into" the materials science field "by accident" and took a composite engineering research position in what is now Materials Science in Radiation and Dynamics Extremes, MST-8. His work on innovative bone-shape short fiber composites, which earned a Distinguished Performance Team Award in 1998 and numerous publications, catapulted Valdez into the research field.

"Those little bits of success really open up the world to you," Valdez said.

Since 1998, when he joined MST-8, Valdez has probed the effect of radiation on oxides at the Ion Beam Materials Laboratory, using a 2-megavolt tandem accelerator that simulates radiation damage. Eight years ago, computer modeling brought a new dimension to his experimental work. Even



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Valdez... though Valdez now has calculations and models to back up his inferences—and computer modeling collaborations have led to publications in such high-profile journals as *Science* and *Nature*—he admits, “We’re still light years behind truly understanding what we see experimentally.”

Expertise earned on the job

Valdez doesn’t hold an advanced degree like most of his peers do, but he feels as though he has earned one, on the job, under the tutelage of many great mentors and collaborators.

Kurt Sickafus, a mentor who worked closely with Valdez over the past 10 years and now heads the University of Tennessee’s Materials Science and Engineering Department, summed up his accomplishments this way: “I have always considered James to be one of the top technicians at LANL. He operated like a staff member, and so I treated him like a staff member. He designed and performed his own experiments and wrote his own research papers, or he co-authored with me and other collaborators . . . I believe James ranks as one of the top 10 authors of journal articles in the Materials Science and Technology Division. These are outstanding achievements for an employee with James’s rank at LANL.”

While Sickafus was principal investigator for a program funded by the DOE Office of Basic Energy Sciences, Valdez was “the inspiration for many of our most significant experiments,” he added, and Valdez mentored all the postdoctoral researchers, students, and visiting scientists working on the program.

Valdez also designed a reflective high-energy electron diffraction system for monitoring in situ radiation damage effects and various hot stages to perform high-temperature radiations (up to 1200C°), an important tool for nuclear fuel development.

When Valdez isn’t coming up with better nuclear fuels, developing stronger materials for nuclear reactors, or testing materials that could be used to contain nuclear waste, he tinkers on his eight-acre farm, which has been in the family every since his ancestors helped settle Dixon. He credits the farming life, particularly his late father’s knack for fixing machinery, as great training ground for a materials science technologist.

“Early in my career, I performed mechanical tests on materials. I was getting paid to break things,” Valdez said. “That’s something I’ve been doing all of my life.”

James Valdez: My favorite experiment

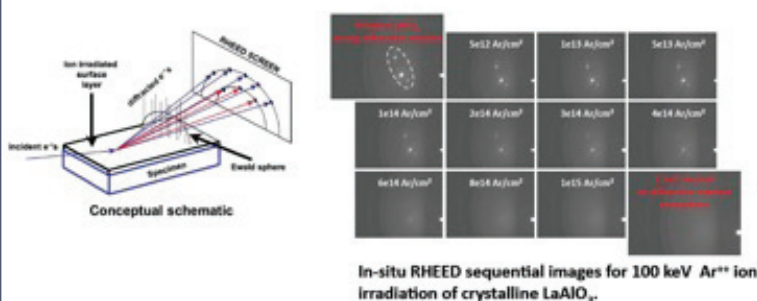
What: First attempt of using reflective high-energy electron diffraction to track in-situ radiation damage in crystalline materials.

When: 2009

Where: Ion Beam Materials Laboratory at Los Alamos National Laboratory

How: The ability to see in-situ radiation damage effects in materials is of great importance to researchers in the field. In 2009 a method was developed to track in-situ ion irradiation damage in materials. This new method uses reflection high-energy electron diffraction (RHEED) to obtain in-situ electron diffraction patterns from crystalline materials during ion irradiation. By observing the collected diffraction patterns during irradiation, experiments can be stopped at precise moments when changes (amorphization, phase transformations, and swelling) in materials take place, allowing for detailed post-characterization using more quantitative techniques. The a-ha moment: RHEED has been used extensively in the area of thin-film growth for many years. In this application, RHEED allows researchers to monitor and control epitaxy during thin film growth.

The a-ha moment in the developmental process of using RHEED to monitor radiation damage was when during an initial test of the system we were able to track the progression of a crystal to amorphous phase transformation produced by Ar⁺⁺ ion irradiation. The conceptual schematic of the RHEED system and the sequence of diffraction patterns obtained from this experiment are shown below.



Twinning dislocations research results in “hottest” *Acta Materialia* paper

Research by Los Alamos scientists resulted in one of the most popular articles appearing April-June 2011 in *Acta Materialia*. Every three months, SciVerse ScienceDirect compiles the top 25 “hottest” research papers, as measured by the number of articles downloaded. The scientific database generates an overall list, as well as top 25 lists for specific subject areas and journals.

Ranking No. 18 as 1 of the “hottest” articles in *Acta Materialia* was work by Jian Wang and Carlos Tome (Materials Science in Radiation and Dynamics Extremes, MST-8, Irene Beyerlein (Fluid

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Twinning... Dynamics and Solid Mechanics, T-3), and John P. Hirth (Center for Integrated Nanotechnologies, MPA-CINT), which identified the elementary twinning dislocations for $\{\bar{1}011\}$ and $\{1013\}$ twins by characterizing their structure for a magnesium crystal. Deformation twinning plays a crucial role in plastic deformation in hexagonal-close-packed (hcp) metals, corresponding to texture evolution, plastic hardening, and fracture, etc. Predicting the operative twinning modes in a given hcp metal under a specified deformation condition still remains a challenge due to the less understanding of twinning dislocations (TDs). Atomistic simulations of twinning in Mg produced the following predictions: the elementary twinning dislocations for $\{\bar{1}011\}$ and $\{1013\}$ twins are two-layer, not four-layer that has been widely adopted in different length scales of models (Fig. 1a); two-layer TDs are more mobile than four-layer TDs and that the mobility of these twinning dislocations depends strongly on dislocation character (Fig. 1(b) and (c)). This comprehensive understanding enables people to correct the existing analytical and numerical material models, predict the nucleation and growth of deformation twins, and refine the experimental characterization of twins.

This work is part of the DOE Office of Science, Office of Basic Energy Sciences core program E401 on "Multiscale characterization of the role of microstructure in the deformation behavior of HCP materials."

Reference: "Twinning dislocations on $\{\bar{1}011\}$ and $\{1013\}$ planes in hexagonal close-packed crystals," *Acta Materialia*, **59** (10) 3990-4001, (2011).

Technical contact: Jian Wang

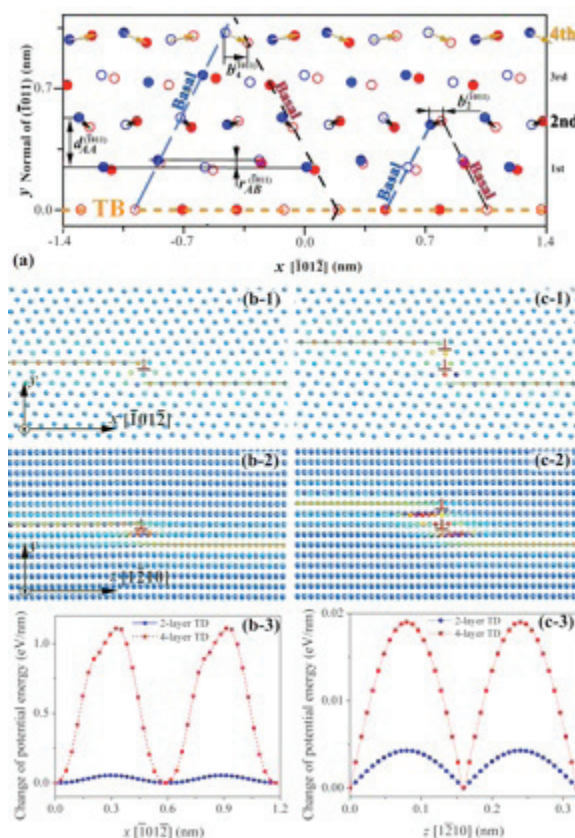


Figure 1. (a) Topological analysis shows two possible twinning dislocations (2-layer and 4-layer) for $\{1011\}$ twins. Core structures of TDs with respect to the line sense: the 2-layer TD perpendicular to the twinning direction (b-1) and parallel to the twinning direction (b-2), and the 4-layer TD perpendicular to the twinning direction (c-1) and parallel to the twinning direction (c-2). The Peierls barriers of TDs with respect to their line sense: (b-3) perpendicular to the twinning direction and (c-3) parallel to the twinning direction.

MST research highlighted at technical symposium

Materials Science and Technology scientists, and Los Alamos National Laboratory overall, had a strong presence at the recent All-Technology Coordinating Groups Symposium-Rodeo in Monterey, Calif. Sponsored by the Joint Department of Defense/Department of Energy Munitions Technology Development Program (JMP), which fosters collaborations between researchers at both departments who working on problems of common interest, the 4-day event in November drew 233 participants.

Rusty Gray and Ellen Cerreta (Materials Science in Radiation and Dynamics Extremes, MST-8) presented research on structural, mechanical, and shock loading response while also discussing modeling of non-nuclear defense materials. They reviewed small-scale experiments in their JMP-sponsored project, including the mechanical behavior of aluminum alloys 7039, 5083, and 5059

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Celebrating service

Congratulations to the following MST Division employees celebrating service anniversaries this month:

David Pugmire, MST-16 10 years
Jason Cooley, MST-6 15 years

MST e-NEWS

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EPS Communications, at 606-1822, or kkippen@lanl.gov.

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To read past issues, please see www.lanl.gov/orgs/mst/mst_eneews.shtml.



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Symposium ... and also summarized the effects of temperature on the dynamic sphere extrusion responses of zirconium, tantalum, depleted uranium, and U-6Nb.

John Bingert (MST-8) and his project team presented a technical update of JMP's Dynamic Properties of Materials Project for fiscal year 2011. Focus topics within six overall tasks included 3D microstructural mapping of damage in copper and a localization evolution experiment utilizing various integrated characterization techniques.

Presenting posters were the following:

- Ellen Cerreta, Alejandro Perez-Bergquist, Rusty Gray, Carl P. Trujillo (MST-8), F. Cao, (former LANL postdoctoral researcher, now at Exxon Corporation) on the "Role of grain orientation on dynamic damage."
- Shuh-Rong Chen, Carl Cady, Mike F. Lopez, Sara J. Perez-Bergquist, Rusty Gray (all MST-8) on "Mechanical Property and Constitutive Modeling of HF-1 and Ductile Cast Steels."
- Veronica Livescu, Rusty Gray, Ellen Cerreta (MST-8), Lawrence Hull and James R. Faulkner (Focused Experiments, WX-3), Matthew Briggs (DARHT Experiments and Diagnostics, WX-4), and Mike F. Lopez (MST-8) on "Microstructural Effects of Shockwave Obliquity in Copper and Tantalum."
- Jevan Furmanski, Cheng Liu, Bruce Orlor (Polymers & Coatings, MST-7), Carl Cady, Philip Rae (Explosive Applications and Special Projects, WX-6), Dana Dattelbaum (Shock and Detonation Physics, WX-9), Eric Brown (Neutron Science and Technology, P-23), and Brad Clements (Physics and Chemistry of Materials, T-1) on "Experimental Polymer Mechanics for Improved Constitutive Modeling and Performance."

In total, 10 Los Alamos scientists presented talks and Los Alamos scientists participated in 11 poster sessions. The symposium brought together a broad cross-section of scientists from Los Alamos National Laboratory, Sandia National Laboratories, Lawrence Livermore National Laboratory, the Office of the Secretary of Defense, the U.S. Army, the Air Force Research Laboratory, the Armament Research, Development and Engineering Center, Naval Air Systems Command, and the Naval Air Warfare Center Weapons Division.

Technical contacts: Rusty Gray and John Bingert

Radiation detection scintillator receives patent

Materials Technology-Metallurgy (MST-6) scientist Chris Chen received a patent in December for a polycrystalline scintillator that can be used as a gamma-ray detector. This invention is a polycrystalline spinel scintillator uniquely designed for special



Transparent $\text{MgAl}_2\text{O}_4:\text{Ce}^{3+}$ polycrystalline scintillator.

nuclear materials (SNM) detection and for medical instrumentation, such as high-definition computed tomography (HDCT).

Though polycrystalline magnesium aluminate spinel has been studied periodically since the 1960s, researchers in the past mainly focused on infrared radome technology and transparent armor applications. Few spinel researchers were dedicated to gamma-ray detection. Polycrystalline spinel can transmit light from 200 to 5500 nanometers, with no optical distortion. The spinel scintillator invented in this patent has great potential as a gamma-ray detector due to its outstanding optical and non-hygroscopic properties (see figure). Its mechanical properties are comparable to polycrystalline aluminum oxide. Polycrystalline scintillators can be manufactured with a fast production rate and a low cost. Furthermore, large size polycrystalline scintillators can be achieved easily through the conventional ceramic processing method. Large size, low cost, and fast production rate are unique features that the single crystal growth process cannot compete with and are important for the SNMs detection and medical industries.

Paul G. Weber, program manager of Global Security Programs, Nuclear Nonproliferation and Security (GS-NNS), sponsored the work, which supports LANL's Global Security mission area and the Science of Signatures science pillar. Reference: "Scintillator having a MgAl_2O_4 host lattice," U.S. Patent No. 8,080,175.

Technical contact: Chris Chen

HeadsUP!

Report slippery spots to 667-6111

With more than 37 slip/trip accidents since December 1, and a cycle of freezing and thawing creating new ice spots every day, safety managers want to remind employees that anyone can and should use the Snow Control hotline to report slippery spots: call 667-6111. Crews from Roads & Grounds will be dispatched as soon as possible to address the problem.

New phone service at Occupational Medicine

LANL workers can call one number at Occupational Medicine for questions about medical issues. The new number, 667-0660, gives callers a series of prompts they can follow to obtain services from Occupational Medicine medical staff.